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By-Rutgers, Norman L.

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Some of the problems of renovating school buildings and in particular the modernization of mechanical services in existing facilities are discussed. According to school management publications, approximately 42 per cent of our elementary and 59 per cent of our secondary schools are 15 years old or older. School plants, which were built 12 to 15 years ago, are today second-class educational facilities and deserve more attention than they are currently being given. These plants require revisions in order to create adequate thermal and accoustical environments to provide today's student with functionally efficient classroom facilities. When modernizing mechanical equipment, a combined report by a qualified mechanical engineer and mechanical contractor should be written. This report should relate the condition of the system as it exists, and it should also include an estimate on the cost required to bring this system up-to-date. (RH)

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MODERNIZING MECHANICAL SERVICES

by Norman L. Rutgers

This afternoon I would like to discuss with you one of the most serious problems that exist in the physical facilities of our educational programs. We all seem to be caught up with current design trends, using the buzz words of building systems for education, program teaching, team teaching, and a dozen and one other terms, cliches, and concepts. Most of this conversation relates to new school facilities. As the population of this country continues to expand, virtually to the explosion point, there is absolutely no question of the importance of new facilities to take care of this emerging crop of children who must be educated. I feel that great progress has been made in the area of design, and also in the area of technology, to give us excellently equipped schools to enable us to do most of the things that we recognize as being important, and even the capability of doing those things which we, today, do not recognize, but which most certainly will emerge within the very near future.

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The school plant, which was built approximately 12 to 15 years ago and those built prior to that time, are really the second class educational facility which deserves much more attention than most of us will recognize. According to the school management publication, approximately 42 percent of the elementary schools are 15 years old

and older and approximately 59 percent of the secondary schools are 15 years old or older. Those schools built prior to 1955 do not reflect the requirements or the needs as today's designs stipulate. In order to give you a very small thumbnail sketch of one facet of this problem, would be to look at some of the work that Dr. Ted Dixon, Superintendent of Schools, Department of Education, San Diego, County, California, learned when he had contacted several leading educational authorities over the country. Ted Dixon received replies from over 13 states, in addition to replies from the Health, Education, and Welfare, one of the leading school architects in the South and also the Council of Educational Facilities Planners, all of whom agreed that the school designs prior to 1955 were extremely restrictive in adapting modern educational programs.

Going back to some of the earlier traditional Quincy School, Boston, Massachusetts types of schools, we find that the total environment for learning, while it was adequate for its day, certainly is far from adequate based on the demands that we place on the teachers and students of this present period. This rigid alignment of the egg crate concept in which the walls so frequently are load bearing and resist any effort made to get out of the confines of the egg crate are still with us in horrifyingly large numbers.

Following World War II, we began to become more daring with our designs and the finger plan evolved. All the way through the 1950's, schools of this particular concept appeared in virtually every state of the union and in rather frightening quantities. Again, each step

in the school design was certainly better than the preceding step, but along about 1950 to 1955 was the time that education really began to break out of its own restraints. It did not take long to learn that in order to break educationally, we also had to break out physically of the restrictive limiting confining spaces that we had spent years generating.

Many people, even extremely knowledgeable educators have asked the question, "Why is air conditioning so necessary now when it was not considered necessary at the time the schools were built?" After all, we have developed many knowledgeable people through our educational systems in the past and the lack of what you currently call a good thermal environment did not seem to inhibit necessarily the development of the good student.

Many things have changed since these older schools were designed, the amount of knowledge that we find it necessary to inject into our students today is many times that quantity that you and I received during our educational experiences. We are to the point now that within a 10-year period, all of the amount of the knowledge in the world doubles and if we are to create the conditions that make it possible for the bulk of the students to assimilate this tremendous quantity of knowledge, the environmental conditions surrounding the student take on a new importance.

Our basic living standards have changed over the years. Today it is virtually impossible to go through a normal day without experiencing an air conditioned environment approximately 75% of the times that we are indoors. This includes public buildings, offices, libraries and so forth.

Why then, should we expect to send our children to a point of learning and expect them to function efficiently in an environment which is far below the standards that they would experience in a normal walk through their community.

Our living habits have changed to the extent that traffic conditions today are many times more severe than they were 15, 20, and 25 years ago. These traffic conditions have created sounds and noises which penetrate a building and become very disturbing influences; whereas 25 years ago, there was the occasional sound that might be slightly distracting, today there is virtually a continuous roar of ever-advancing technology. In order to protect ourselves from this pressure of sounds surrounding us, we must isolate ourselves away from sounds which means enclosing ourselves in such a way that a mechanical environment becomes a necessity.

When the finger schools were developed they were much like the schools that were built in Hawaii up until the recent time. The schools were situated so that the winds of the prevailing trades could blow into one side of the school and through a system of window ventilation, ventilate the school and then excape out the opposite side. The finger plan gave maximum exposure to the various wind directions and also this worked reasonably well until our society reached the point of sophistication that is has become necessary to go inside to get a breath of fresh air. Air pollution is not a minor item and it is becoming increasingly important to isolate the pollenants to the outside and remove all irritants and particles before introducing it into the room.

As I mentioned before, the schools in Hawaii were designed to adapt themselves to the wonderful trade winds, but a recent visit to Honolulu showed that the new six-lane freeways which are located within a half a block of several major older schools have created a whole new set of problems that are more difficult to deal with. When a school is built there is no guarantee that automotive noises, jet noises, and several other forms of manmade sound pressures will not create an extremely detrimental effect to a given school.

Finally, and perhaps this should have been put first, the educational programs that you gentlemen are experimenting with and developing are considerably different than they were in the early 1950's. In order to utilize many of the things that is felt represents an improvement in education, we must have some changes in space and also the possibility to increase or decrease spatial areas.

All of these things create real and serious problems to the educator and particularly to the designer. It is far, far easier to start with a clean piece of paper and develop a whole new school plan than it is to take an existing school and update it to meet the standards and criteria of today's educational program.

Modernization (space flexibility) or Rehabilitation (minimum funds for surface improvements)

One of the serious problems in the consideration of modernizing any school plan is the problem of financing. California, for instance, will not allocate any state funding or updating or modernization, in fact, it might appear that the state of California would rather see you

tear down a building that still has many years of service left and will help to pay for a replacement for that building. Obviously, this is not the intent of the state educational department of California, but their ruling certainly implies that this might be the intent. As a direct comparison to that, the state of Michigan makes absolutely no differentiation as to the expenditure of capital funds for either new facilities or for remodeling. There seems to be a necessity for some real ground work at the legislative levels in several states to recognize the problem of modernization and to deliver the financial support to allow this modernization program to be considered.

Mr. George Reidz, Director of School Facilities Services for the Kansas State Department for Public Instruction has supplied a written review entitled "Modernization of Older School Facilities". This article appears over the letterhead of the state department of public instruction for Kansas and embraces many interesting problems. When considering the modernization of an older school plan, the site on which the plant is located frequently is much smaller than the site currently recommended by the Council of Educational Facilities Planners. Some allowance must be made for the criteria established by the facility planners in that some of the existing sites of the older schools are in ideal areas of the community and as the article points out, these sites are frequently surrounded by fine older homes which are occupied by families which are interested in quality education for their children. Many of the sites have older trees and shrubs which can be used to advantage. Again, here I think it takes perhaps more

thought and more ingenuity to get the most out of the site when modernization is considered.

Before a modernization program is tackled, it is just as important to have a well-developed and well written educational specification for the modernizing program as it is for a new school. Far too frequently the fact that the project is called modernization precludes any thought of using educational specifications. As the Kansas article points out, "Ideas, rather than masonry must be the point of beginning if the design or modernization of the school is to effectively accommodate the student and the educational program of the future."

One of the interesting criteria that Kansas uses is that the facility should not be modernized if the cost will exceed 50% of the cost of replacing the existing building with a new facility. It is the opinion of the majority of educators that schools older than 30 years should not be modernized. Basically, it is assumed that the life expectancy of the modernized building will be considerably less than that of a new building. However, this statement is subject to some question, particularly in view of some of the new schools that I have seen constructed throughout the country. I would say that many 20-year old schools built and constructed well, could well outlast a one-year old school that is poorly constructed with poor materials.

Many changes in building codes have occurred since the original buildings were built, and adhering to the newer codes, with an older building will undoubtedly create some very serious design problems. These problems cannot be placed in any specific category, but must be

handled individually as they present themselves. One of the biggest problems that seems to exist not only in Kansas, but in virtually every part of the country is that many school districts would like to modernize their facilities but they do not have any sort of criteria or any examples that they could follow in their modernizing program.

There have been so few schools that have been actually updated and modernized that it is all but impossible for any school board to locate a modernized facility and to visit this facility and to learn just how the local school district handled the problem.

Inasmuch as the title of this talk was to be modernizing the mechanical services, I do think that I should spend a brief amount of time before concluding the talk and discuss mechanical problems. There are basically three general types of mechanical systems that will be found in the older school. The heating system will be either hot water or steam or warm air. These can take many forms all the way from radiation up to fan coil units, unit ventilators and ducted systems. The state of California and several other states have many warm air systems which are fueled with natural gas, oil, electricity. In some cases even stoker-fired coal is being used in coal producing areas of Pennsylvania and West Virginia.

The schools built 10 to 15 years ago probably have a reasonably well ventilation system, while schools built 20 to 25 years ago have an absolute minimum approach to ventilation, generally using open windows for their ventilation method. When considering the modernizing of a mechanical system on a school of let's say 15 to 20 years old, the very first thing that should be done is the selection of a <u>qualified</u>

engineer and the best mechanical contractor in the area. By obtaining the services of the best people, you frequently will save far more than you would pay for the apparent low bidder with little experience. Often the lack of experience makes him the low bidder. A complete survey of the mechanical system should be made and a combined report should be written by the mechanical engineer and the mechanical contractor. This report should relate the condition of the mechanical system as it exists on the day it was inspected, and also as estimate on the cost required to bring this mechanical system into A number one condition. If air conditioning is to be added to the system, there undoubtedly will be several different methods that could be used. The method that will be suggested will be dependent upon the type of system that exists in the older school. A school with fixed radiation could be served by a system of duct work, provided the construction of the school allows the addition of such duct work.

Frequently the ceiling heights and hallway heights of these older buildings was sufficiently high that a duct distribution system could be run at the ceiling and then a very simple drop ceiling installed. This also offers an excellent opportunity to consider a new lighting system if a drop system is involved.

Access to the out of doors for ventilation air is very important and also a location for the mechanical equipment sometimes presents a very difficult problem. On a single story school, depending upon the construction, the roof will often provide an excellent spot to mount mechanical equipment. If the roof is chosen, considerable care should be taken to isolate the mechanical equipment from the roof itself so

that vibration will not be a problem. If the appearance of units on the roof of a single or a two-story building appears to be objectional, there are many ways in which architectural screening can be used.

The mechanical cooling condensing units can be located on the ground outside of the building, but care must be taken to properly screen and isolate these mechanical units from contact with children during recess periods. Other equipment has been developed which can fit into the exterior of the school and by merely leaving an opening through the outside wall and properly supporting the area above the opening with a lintel, mechanical units can be installed along the perimeter of the building.

If the installation contains unit ventilators and the piping is sufficient to handle a required amount of chilled water, it may be possible, depending upon the particular equipment involved, to merely add a chiller and circulate chilled water through the system during the summer and hot water through the same pipes in the winter. Naturally, the pipes must be insulated and the equipment must either be ready for future cooling or to be able to be adapted for future cooling. This would probably be possible in the newer schools of let's say 8 to 10 years old, but much beyond that period of time of 15 to 20 years of age the schools would probably not be able to accommodate a conversion to chilled water system. The warm air system frequently can be easily converted to cooling and if the system was properly installed initially for ventilation air, in all probability the duct sizes would be large enough to accommodate the mechanical cooling requirements.

If the school is not too old, it might be well to discuss this modernization program with the architectural engineer who did the initial design and mechanical engineering and also if the original contractor is still in existence who installed the job, frequently they will know about the details of the construction and know just how much of a problem would be involved in running the necessary mechanical piping duct work and so forth within the building.

Some thought should be made to the problem of coordinating the existing heating system with the newly added cooling system. It is not feasible to have two separate control systems, one controlling the heating and the other controlling the cooling because with independent control points in individual thermostats, these systems will frequently be fighting each other and very, very poor temperature control will result. If the existing heating system is in good condition, then a real effort should be used to utilize this heating system rather than assuming that a complete new mechanical system for both heating and cooling is necessary. On the other hand, if the mechanical system is in very, very bad shape and the building lends itself to a simple installation of both heating and cooling, it then might be a much more economical decision to install a complete heating and cooling system.

Cost estimates are extremely difficult to develop in modernization work. 21 projects studied in California showed actual modernizing costs exceeded estimate from 10% to 195%; average is 43% excess. It would probably be difficult to get a contractor to give you a cost estimate; however, I think it is absolutely essential that you have some idea of what you are becoming involved in before you call in the

workmen and start to tear out and reinstall. I have seen cost estimates for adding mechanical cooling to an existing system vary from 1.20 a square foot up to $5.50 a square foot. Example: Clark County - $3.50 to $4.00/sq ft - electrical steam absorption. The Ted Dixon Rios Elementary School will be approximately $1.50/sq ft for 96 tons of cooling - 292 sq ft/ton.

Sometimes a unitary approach in which individual mechanical units on a per classroom basis will allow a district to modernize their schools in sections or a room at a time. This has been done over a period of two or three years by using the summer months to do a remodeling job and individual units on a per classroom basis would allow the work to be done in small segments of both time and money. In Richardson, Texas, an 11-school project was completed in 1968; all are 10-15 years old - rooftop equipment was used - $2.00/sq ft.

In reviewing this entire subject of modernizing mechanical services one very glaring fact stands out. There is precious little information or direction that is currently available to the school administrator in giving him some guidelines in just what modernization would involve. This exercise that I have undertaken in developing this brief discussion with you has alerted me to the fact that the number one priority project that I will initiate upon return to our home office in Marshalltown, Iowa, will be the development of as comprehensive a written documentation on modernizing mechanical services that our company is capable of producing. I think that others in our industry should also make an effort to create information on this subject and this information should be of a non-product oriented nature, but should cover the subject

with as many drawings and illustrations as possible the various existing systems of heating and ventilation that are normally found in older buildings and how the systems can be updated to the inclusion of proper ventilation air and mechanical cooling. I believe we must all try a lot harder than we have in the past to eliminate the second class school from our educational scene.

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